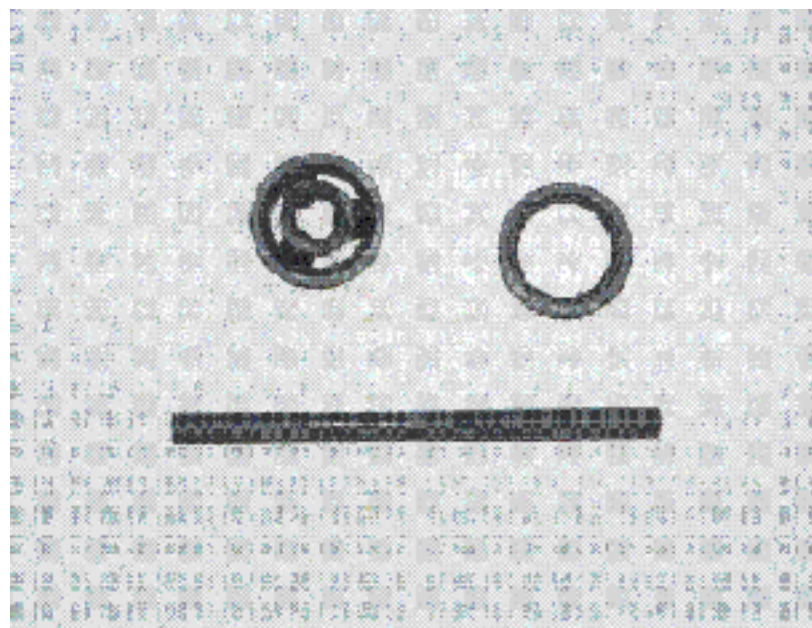




NEW PROCESS MAKES HIGH TEMPERATURE CERAMIC BEARINGS SELF LUBRICATING



Payoff

Self lubricating ceramic bearings will allow bearing sumps in expendable gas turbine engines to operate without cooling air and external hardware to supply lubricant to the bearings; thus, providing improvements in engine performance and reductions in engine cost and weight. The inexpensive reaction process used to make a lubricious layer at the bearing surface can be applied to ceramic bearings in a production environment.

Accomplishment

A reaction process developed under a program sponsored by the Propulsion Directorate's Fuels and Lubrication Division enables ceramic bearings to be self lubricating at elevated temperatures. The self lubricating silicon nitride (Si_3N_4) bearings performed for 50 hours in subscale tests at 1250 degrees Fahrenheit and still maintained their critical mechanical properties.

Background

During the last decade, government agencies and industry have expended a significant amount of funds and manpower to develop Si_3N_4 rolling element bearings. High quality Si_3N_4 bearings are available from both domestic and foreign sources. A specific advantage of Si_3N_4 bearings is their high temperature capability. However, to capitalize on this advantage, high temperature lubricants

are required. Since 1987, the Fuels and Lubrication Division has tested numerous inorganic compounds in the form of coatings and powders to identify high temperature lubricants for Si₃N₄ ceramics. Of the compounds tested, those containing cesium (i.e., CsMoOS₃, Cs₂WOS₃, Cs₂WO₄, Cs₂SO₄ and CsOH) have been particularly impressive. Post test surface analysis of bearing specimens coated with these compounds revealed high levels of silicate (SiO₂) and cesium. This led in-house researchers to postulate that cesium silicates (i.e., Cs₂O°SiO₂) produced via chemical reactions with the ceramic material are actually the lubricating species. Additional tests conducted in 1993 confirmed that Cs₂O°SiO₂ is a high temperature lubricant when applied as a coating. In 1994, a small business contract with the Desilube Company of Lancaster PA was modified to develop a process to produce cesium silicates in the matrix of a ceramic surface as a pretreatment for bearing operation. The intended goal was to make a self lubricating layer at the bearing surface while still maintaining the critical mechanical properties of Si₃N₄ throughout most of the substrate material. A patent application has been filed by the Air Force pertaining to cesium silicates as high temperature lubricants.